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CULTURES OF UREDINEAE IN 1902.[1]

J. C ARTHUR.

THE present article forms the third of a series of reports by the author upon the cultures of plant rusts. The first one[2] covered the year 1899, the second[3] combined the years 1900 and 1901, and the third covers the year 1902. Like the preceding ones, the present report is devoted largely to the heteroecious grass and sedge rusts. The methods employed have already been described in connection with the previous reports.

The work was much more extended during the present season than had been possible in preceding years through the interest taken in it by the authorities of Purdue University, who generously defrayed the expense of additional assistance during the months of May and June, when the largest part of the work must be done. In this way it became possible to have the help for a time of Mr. Oliver P. Terry, an undergraduate of the university, and an unusually skilful manipulator. But the larger part of the testing with drop cultures and of the application of the spores to the plants throughout the whole of the busiest period was undertaken by Miss Julia Titus Emerson, of New York City, coming from the New York Botanical Garden, who showed great earnestness and rare judgment in carrying on the work.

During the present season 123 collections of material were employed, and 314 drop cultures were made from them to test the germinating condition of the spores. Out of these 23 collections refused to germinate, and were consequently useless. There were in all 327 plant cultures attempted, representing 43 species of rusts, and employing 102 species of hosts temporarily grown in pots in the greenhouse. In no case was success attained where definite clues derived from field observations were lacking.

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[1] Read before the Botanical Society of America, Washington, Jan. 1, 1903.

[2] BOT. GAZ. **29**: 268–276. April 1900.

[3] Jour. Mycology **8**: 51–56. June 1902.

Fourteen species were tried this year by the guessing method, no clues being known, and the following is a record of the failures, together with one instance, that of the Panicularia rust, where a seeming clue also failed. Teleutospores were employed in every case.

1. MELAMPSORA from *Populus deltoides* Marsh. was sown on *Larix europaea*, *Abies balsamea*, *Euonymus obovatus*, *Stylophorum diphyllum*, *Helianthus strumosus*, and *H. grosse-serratus*, with no infection.

2. MELAMPSORA on *Salix discolor* Muhl. was sown on *Larix europaea*, *Abies balsamea*, *Picea canadensis*, *Euonymus obovatus*, *Ribes aureum*, *R. gracilis*, and *Helianthus grosse-serratus*, with no infection.

3. UROMYCES JUNCI Tul. from *Juncus tenuis* Willd. was sown on *Iris versicolor*, with no infection.

4. UROMYCES SPOROBOLI E. & E. from *Sporobolus longifolius* (Torr.) Wood was sown on *Ceanothus americanus* and *Verbena stricta*, with no infection.

5. UROMYCES HALSTEDII De T. from *Homalocenchrus virginicus* (Willd.) Britt. was sown on *Senecio obovatus* and *Bidens frondosa*, with no infection.

6. PUCCINIA ELEOCHARIDIS Arth. from *Eleocharis palustris* (L.) R. & S. was sown on *Iris versicolor*, with no infection.

7. PUCCINIA SCHEDONNARDI K. & S. from *Schedonnardus paniculatus* (Nutt.) Trel. was sown on *Lepidium apetalum*, *Ceanothus americanus*, *Oxalis cymosa*, *Apocynum cannabinum*, *Cassia Chamaecrista*, *Symphoricarpos racemosus*, *Xanthium canadense*, *Kuhnistera purpurea*, and *Lacinaria scariosa*, with no infection.

8. PUCCINIA MUHLENBERGIAE A. & H. from *Muhlenbergia racemosa* (Mx.) B. S. P. was sown on *Napaea dioica*, *Impatiens aurea*, *Oxalis cymosa*, *Anemone canadensis* and *A. virginiana*, *Hydrophyllum appendiculatum*, *Phlox divaricata*, *Physalodes Physalodes*, *Apocynum cannabinum*, and *Helianthus grosse-serratus*, with no infection.

9. PUCCINIA CHLORIDIS Speg. from *Chloris verticillata* Nutt. was sown on *Quamasia hyacinthina*, with no infection.

10. PUCCINIA SPOROBOLI Arth. from *Sporobolus heterolepis* Gray was sown on *Isopyrum biternatum*, *Oxalis cymosa*, *Xanthoxylum americanum*, *Ribes Cynosbati*, *Cassia Chamaecrista*, *Symphoricarpos racemosus*, *Verbena urticifolia*, *Senecio obovatus*, *Solidago rigida*, *Helianthus Maximiliani*, *Boltonia asteroides*, and *Brauneria purpurea*, with no infection.

11. PUCCINIA PURPUREA Cke. from *Tripsacum dactyloides* L. was sown on *Zea Mays*, with no infection.

12. PUCCINIA STIPAE Arth. from *Stipa spartea* Trin. was sown on *Aesculus glabra*, *Cassia Chamaecrista*, *Psoralea Onobrychis*, *Symphoricarpos racemosus*, *Hydrophyllum appendiculatum*, *Xanthium canadense*, *Boltonia asteroides*, *Lacinaria scariosa*, and *Brauneria purpurea*, with no infection.

13. PUCCINIA PANICULARIAE Arth. from *Panicularia americana* (Torr.) MacM. was sown on *Boltonia asteroides*, with no infection, although three sowings were made at different dates and with all conditions apparently favorable. This seems to contradict the inference of the writer drawn from field observations (Bull. Torr. Bot. Club **28**: 664).

14. PUCCINIA EMACULATA Schw. from *Panicum capillare* L. was sown on *Impatiens aurea*, *Lactuca canadensis*, and *Eupatorium perfoliatum*, with no infection.

15. PUCCINIA POLYGONI-AMPHIBII Pers. from *Polygonum emersum* (Mx.) Britt. was sown on *Polygonum pennsylvanicum* and *P. virginianum*, with no infection.

Twelve species of rusts were successfully grown, that have been studied with success before, and reported upon by the writer and others. They are enumerated here by way of confirmation, and also in some cases because additional hosts are included. The list is as follows:

1. UROMYCES EUPHORBIAE C. and P.—June 19, aecidiospores from *Euphorbia humistrata* Engelm. were sown on the same host, and were followed by uredo on July 8, and also on *E. nutans* and *E. marginata*, with no infection. July 11, aecidiospores from

E. nutans Lag. were sown on the same host, and were followed by uredo on July 21, and also on *E. humistrata* and *E. marginata*, with no infection. July 22, uredospores from *E. dentata* Michx. were sown on the same host, and were followed by uredo on Aug. 14, and also on *E. humistrata*, *E. nutans*, and *E. marginata*, with no infection. These results, taken in connection with those previously obtained by the writer,[4] leave no opportunity for doubt that the Euphorbia rust is separable into a number of well established races, or possibly into true species.

2. UREDO RUBIGO-VERA DC.—May 31, uredospores from *Triticum vulgare* Vill. were sown on *Triticum vulgare*, and produced uredo on June 13, and at the same time on *Hordeum jubatum*, *Poa compressa*, *Dactylis glomerata*, and *Bromus ciliatus*, with no infection.

3. PUCCINIA PECKII (De T.) Kellerm.—The connection of a Puccinia on *Carex trichocarpa* Muhl. and *Aecidium Peckii* De T. on *Onagra biennis* (L.) Scop. (*Oenothera biennis* L.) has already been reported by Kellerman,[5] and it was due to the suggestion from Professor Kellerman, founded upon his field observations, that the writer succeeded in bringing the present season's work to a satisfactory issue.[6] Eleven collections of teleutospores were used: two from Ohio, sent by Professor Kellerman; two from Racine, Wisconsin, sent by Dr. J. J. Davis; two from Spirit Lake, Iowa, obtained by the writer; and the remainder from different localities near Lafayette, Indiana. Seven of these collections were definitely known to be on *Carex trichocarpa*, and four of them, those from Wisconsin and Iowa, were presumably on that host.

Spores from these collections were sown on *Urtica gracilis*, *Anemone canadensis*, *Geranium maculatum*, *Impatiens aurea*, *Sambucus canadensis*, *Ribes gracile*, *R. Cynosbati* and *R. floridum*, *Xanthium canadense*, *Aster Shortii* and *A. paniculatus*, *Solidago canadensis*, *Erigeron annuus*, and *Leptilon canadensis*, with no infection. Successful cultures on *Onagra biennis* were made as follows, the period between the sowing of the dry spores and the appearance of the spermogonia varying from five to seven days, and between the appearance of the spermogonia and the appearance of the aecidia an equal length of time, the two intervals making ten to thirteen days.

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[4] BOT. GAZ. **29**:271. 1900, and Jour. Mycology **8**:51. 1902.

[5] Jour. Mycology **8**:20. 1902.

[6] For record of previous failures see Jour. Mycology **8**: 52. 1902.

CULTURES OF PUCCINIA FROM CAREX TRICHOCARPA ON ONAGRA BIENNIS.

Teleutospores sown	Spermogonia appeared	Æcidia appeared
April 26	May 1	May 7
May 2	May 8	May 13
May 2	May 8	May 15
May 2	May 9	May 15
May 5	May 10	May 16
May 7	May 12	May 19
May 7	May 13	May 19
May 7	May 14	May 19
May 7	May 14	May 19
May 9	May 15	May 21
May 27	June 2	June 7
May 28	June 2	June 7
May 29	June 4	June 9

A collection on *Carex stipata* Muhl. also was made near Lafayette, Indiana, spores from which were sown on *Ribes Cynosbati*, *R. floridum*, *R. Uva-crispa*, *Aster paniculatus*, *A. prenanthoides*, *Solidago canadensis*, and *S. serotina*, with no infection. It was not until aecidia were found in the field on seedlings of *Onagra biennis*, growing close to the Carex still bearing dead leaves covered with teleutospores, that the right plant was selected for cultures. Teleutospores were sown on *Onagra biennis* June 23; spermogonia appeared in great abundance July 1, and aecidia July 8.

4. PUCCINIA BOLLEYANA Sacc. and P. ATKINSONIANA Diet.—The connection of *Puccinia Bolleyana*, which occurs on *Carex trichocarpa* Muhl., with *Aecidium Sambuci* Schw. has already been reported by the writer.[7] This has been confirmed by further successful trials. Material gathered from the type locality of *P. Bolleyana*, when examined under the microscope, was found to show only a small proportion of the characteristic spores of

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[7] Jour. Myc. **8**: 55.

this species, and a large proportion of much smaller spores, which were surmised to belong to *Puccinia Peckii.* Sowings were made, May 5, on *Sambucus canadensis* and *Onagra biennis.* May 10, abundant spermogonia appeared on Onagra, followed May 16 by aecidia. On Sambucus spermogonia appeared sparingly May 13, followed by aecidia May 21. The sedge, therefore, bore two species of rust in 1901, intermixed on the same leaves. In addition to this, on May 19, aecidiospores from *Sambucus canadensis* were sown on *Carex trichocarpa*, which gave rise to uredo on May 27. The connection of *Puccinia Bolleyana* with *Aecidium Sambuci* appears to be proven beyond question.

Two collections of *Puccinia Atkinsoniana* on *Carex lurida* Wahl. were sent from Columbus, Ohio, by Professor Kellerman, with the suggestion, which seemed to me at the time very improbable, that the aecidia doubtless occurred on *Sambucus canadensis.* Another collection was secured from the vicinity of Lafayette, Indiana. Two sowings were made on *Onagra biennis* without infection. One sowing from each of the three collections was made on *Sambucus canadensis* with abundant success in each case. The dates are respectively April 28, May 7 and 16 ; April 29, May 5 and 16; and May 7, 12, and 21. Professor Kellerman has written me that his cultures also gave similar results.

These discoveries led to a careful microscopic study of the two Carex rusts, and there appears to be no reason to question that *P. Atkinsoniana* and *P. Bolleyana* are identical. In the designation of the species it seems necessary on grounds of priority to abandon both these names, however, and it becomes **Puccinia Sambuci** (Schw.), nom. nov.

5. PUCCINIA CARICIS-ASTERIS Arth.—A collection of this species on *Carex foenea* Willd. was sown on *Solidago serotina,* with no infection. It was also sown, May 2, on *Aster paniculatus* Lam., and was followed by spermogonia May 8, and aecidia May 19, thus confirming the writer's previous work.[8]

6. PUCCINIA CARICIS-ERIGERONTIS Arth.—A collection of this rust on *Carex festucacea* Willd. was used for cultures on *Erigeron*

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[8] Jour. Mycology **8**:54. 1902.

annuus (L.) Pers., *E. philadelphicus* L., and *Leptilon canadense* (L.) Britt., with the most unqualified success. The work of last year[9] is thus confirmed, and additional hosts ascertained.

7. PUCCINIA CARICIS (Schum.) Reb.—A collection of this rust on *Carex stricta* Lam., sent by Rev. J. M. Bates from Callaway, Nebraska, gave rise to aecidia when sown on *Urtica gracilis* Ait., the dates for sowing, appearance of spermogonia and aecidia being respectively May 24, June 2 and 7. The experimental proof of this connection has been reported[10] twice previously for American material. A collection sent by Mr. E. W. D. Holway from Decorah, Iowa, on *Carex riparia* Curt. was sown on *Ribes Cynosbati*, *R. gracile*, *R. aureum*, *R. floridum*, and *R. Uva-crispa*, *Geranium maculatum*, *Onagra biennis*, *Sambucus canadensis*, and *Xanthium canadense*, with no infection. It was sown on *Urtica gracilis* May 21, and gave spermogonia May 27, and aecidia June 2.

8. PUCCINIA VILFAE A. & H.—The alternate form of this rust has been shown[11] to be *Aecidium verbenicola* K. & S. These results have been verified this season by sowing teleutospores from *Sporobolus longifolius* (Torr.) Wood, collected at Callaway, Nebraska, by Rev. J. M. Bates, on *Verbena stricta* Vent. (culture dates May 28, June 3 and 10) and on *V. urticifolia* L. (culture dates the same). A collection from Lafayette, Indiana, on the same host, was also sown on *V. urticifolia* with success (culture dates May 2, 10, and 19). To conform to present knowledge the name of the rust should be written **Puccinia verbenicola** (K. & S.), nom. nov.

9. PUCCINIA WINDSORIAE Schw.—A collection of the teleutospores of this species of rust on *Tricuspis seslerioides* Torr. (*Triodia cuprea* Jacq.) was sent from Denton, Texas, by Mr. W. H. Long, Jr., with the statement that *Æcidium Pteleae* B. & C., which has been taken to be the alternate form of the rust,[12] had not been observed in that vicinity. This material was sown on *Ptelea trifoliata* L., May 9, and spermogonia appeared May 15, followed by abundant aecidia May 24.

[9] Jour. Mycology **8**: 54. 1902.

[10] BOT. GAZ. **29**: 279. 1900, and Jour. Mycology **8**: 52. 1902.

[11] BOT. GAZ. **29**: 274. 1900.

[12] BOT. GAZ. **29**: 273. 1900.

10. PUCCINIA HELIANTHI Schw.—Cultures showing this species to be autoecious have heretofore been made with American material only by Carleton[13], but have been reported from Europe. Teleutospores gathered in this vicinity on *Helianthus grosse-serratus* Mart. were sown on the same species of host with success (culture dates May 8, 17, and 23) and also on *H. Maximiliani* Schrad. (culture dates May 8, 16, and 22), but sowings at two different dates on *H. strumosus* gave no infection. This evidence of races, so far as it goes, does not accord with Carleton's opinion that "there is no distinction of host forms."

11. PHRAGMIDIUM SPECIOSUM Fr.—A successful culture[14] of this species of rust was again tried, using teleutospores from a hardy garden rose, obtained at Spirit Lake, Iowa, and sowing them on *Rosa humilis* Marsh. The culture was made April 24, and vigorous spermogonia appeared May 3, but the leaves gradually withered without the formation of the aecidial stage.

Beside the foregoing negative and confirmatory results, successful cultures were made establishing aecidial and teleutosporic association, heretofore unknown, for seven species of heteroecious grass and sedge rusts.

1. UROMYCES ARISTIDAE E. & E.—The material for the study of this species was received from Mr. W. H. Long, Jr., who suggested that its aecidial form was to be looked for on various species of Plantago. Teleutospores on *Aristida oligantha* Michx. were collected the middle of March, at Denton, Texas. Sowings were made from this material on *Plantago Rugelii* Dec., May 2, from which spermogonia arose May 13, and aecidia May 20. The development was not luxuriant, but very characteristic. A sowing on the same date on *P. lanceolata*, and later sowings on both species gave no infection. It would seem that these two species of Plantago are less suited to the ready development of the species than other members of the genus. The middle of April I received from Mr. Long freshly gathered aecidia on *Plantago virginica* L., and on two undetermined species, which are doubt-

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[13] Science **13**:250. 1901.

[14] For previous record see BOT. GAZ. **29**:271. 1900.

less *P. Purshii* R. & S. and *P. aristata* Michx. I also have it in my herbarium on *P. virginica* from Illinois (Ellis and Everhart's N. Amer. Fungi, no. 1829), on *P. Purshii* from Nebraska (Fungi Columbiani, no. 1475), and on *P. eriopoda* Torr. from Montana, collected by F. D. Kelsey. The aecidium has passed under the name of *A. Plantaginis* Ces., but the identity with the European form needs verification, although microscopically the two are very similar.

2. PUCCINIA BARTHOLOMAEI Diet.—Again I am indebted to Mr. W. H. Long, Jr., for material and suggestions leading to the discovery of the aecidial connection of this host. Under date of April 8, 1902, he wrote: "I have never found *Puccinia vexans* in the state, although it is reported from Texas; *P. Bartholomaei* I have found, also its aecidial stage, which is *Aecid. Jamesianum* on *Asclepiodora decumbens*. I have never found this milkweed with aecidia on it, that I did not find teleutospores of *P. Bartholomaei* thickly covering the leaves of *Bouteloua curtipendula* around and under the milkweed, and the teleutospores when examined had germinated. Later the young grass in and near the bunches of infected milkweed would first show the rust; and where no teleutospores were found under or near the milkweed no aecidia were seen. This I observed repeatedly in my field work last year."

Mr. Long sent teleutospores on *Atheropogon curtipendulus* Fourn. (*Bouteloua curtipendula* Torr.), which were sown on *Asclepias incarnata* L. on May 2, giving rise to spermogonia May 8, and aecidia May 17. They were later sown with success on the same host (culture dates, May 21, 28, and June 5), and on *Asclepias syriaca* L. (culture dates, May 12, 18, and 26). They were also sown at two different dates on *Apocynum cannabinum*, with no infection.

As the specific name of the aecidium is older than that of the teleutosporic stage, the name of the fungus should become **Puccinia Jamesiana** (Pk.), nom. nov.

3. AECIDIUM IMPATIENTIS Schw.—The aecidium on Impatiens, and there appears to be but one, is very common throughout the eastern United States. It often occurs in a locality in the great-

est abundance, frequently affecting the leaves and stems of nearly every plant in a large area where the host may be growing thickly. Such a group of plants has been under observation for a number of seasons. In a space some twenty feet across, protected by a group of willows, many hundreds of *Impatiens aurea* Muhl. have sprung up from seeds each succeeding spring, and when from six inches to a foot high have become remarkably infested with aecidia. A rather large number of grass and sedge rusts occur in the vicinity of this spot, and the teleutospores of these have been sown in succession on Impatiens, and invariably with no infection. It was not until well into June of the present year that any clue was obtained. A tuft of *Elymus virginicus* L., growing at the edge of this patch of infested Impatiens, was found to possess young sori of some uredo. Searching further, dead leaves of the previous season were obtained bearing inconspicuous sori of what has generally been called *Puccinia rubigo-vera*, the teleutospores of which had already germinated. A collection on the same host was in the laboratory, however, that had been obtained early in the season from a locality some miles distant, which was still in germinating condition, Teleutospores from this were sown on *Impatiens aurea*, June 10, spermogonia following abundantly June 17, and aecidia June 25. Spores from the same collection had been sown previously on *Ambrosia trifida* and *Napaea dioica*, with no infection.

There are other creditable species of Puccinia on Elymus in the Rocky mountain and Pacific states, but this is the most common species and possibly the only one in the eastern states. It should be called **Puccinia Impatientis** (Schw.), nom. nov.

4. PUCCINIA SUBNITENS Diet.—I am indebted to Rev. J. M. Bates, of Callaway, Nebraska, for material to make the cultural study of this species, and for the suggestion which made the study fruitful. He wrote that wherever the grass rust occurred he had observed an aecidium on *Chenopodium leptophyllum* (Moq.) Nutt.

Teleutospores from *Distichlis spicata* (L.) Greene were sown on *Chenopodium album* L. on May 24, and on May 31 spermogonia appeared in the greatest luxuriance, followed by aecidia on June

3. A second sowing was made May 27, with spermogonia June 3, and aecidia June 9, in equal abundance. The crumpling of the leaves by the aecidia, and their bright orange color, made these the most striking cultures of the season. This aecidium is undoubtedly *A. Ellisii* Tr. & Gall., founded on a collection from New Mexico.

5. PUCCINIA AMPHIGENA Diet—In the year 1883 the type collection for this species was made by the writer at Ravenswood, now a part of Chicago. The same season an aecidium was found on *Smilax herbacea* in the immediate vicinity,[15] which appeared to be *A. Smilacis* Schw. Owing to the limited distribution of these two forms, and their association within a seemingly restricted area, their possible genetic connection was thought worth testing. This opinion was strengthened by the fact that the grass rust has been collected a number of times since by the writer in the same locality, but no other aecidium has been found there at all likely to belong to it.

Teleutospores on *Calamovilfa longifolia* (Hook.) Hack., kindly sent by Rev. J. M. Bates from Callaway, Nebraska, were sown May 13 on both *Smilax herbacea* L. and *S. hispida* Muhl., and on May 20 both showed spermogonia, and May 31 aecidia. A second sowing on May 27 was only partially successful, as the leaves prematurely withered.

6. PUCCINIA SIMILLIMA Arth.—At the time of the publication of this species the writer called attention[16] to its probable connection with an aecidium on *Anemone canadensis*, which occurred in great abundance in the immediate vicinity.

Teleutospores on *Phragmites Phragmites* (L.) Karst. (*P. communis* Trin.), obtained by the writer from the type locality at Spirit Lake, Iowa, were sown on *Anemone canadensis* L., May 1, producing spermogonia May 5, and aecidia May 13. They were also sown, partly at the same time and partly later, on *Anemone cylindrica*, *A. virginiana*, *Pulsatilla hirsutissima*, and *Ranunculus septentrionalis*, all seemingly reasonable hosts, but with no infection. The aecidium has passed for *Aecid. Ranunculacearum*, but whether it is distinct or not from the similar aecidia which have been found on the other hosts mentioned cannot now be stated.

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[15] See BURRILL, Parasitic Fungi of Illinois 238.

[16] BOT GAZ. 34: 18. 1902.

7. AECIDIUM SOLIDAGINIS Schw.—Having found Puccinia teleutospores on *Carex Jamesii* Schw., they were sown on four species of Ribes, with no infection. They were then sown on six species of Aster, with no infection. At about the same time, May 9, they were sown on *Solidago canadensis* L., and followed by spermogonia May 15, and aecidia May 22. On May 24 a sowing was again made on *S. canadensis*, and also on *S. ulmifolia* Muhl., *S. caesia* L., *S. rigida* L., and *S. serotina* Ait., all of which produced spermogonia in ten to twelve days, but only the last developed aecidia. Part of these trials were repeated, and sowings also made on three additional species of Solidago, but without success. These failures appear to have been due chiefly to the feeble condition of the host plants.

A collection of Puccinia on *Carex stipata* Muhl., sent by Mr. E. W. D. Holway from Decorah, Iowa, was used for cultures on four species of Ribes, and on *Erigeron annuus* and *Onagra biennis*, with no infection. Afterward it was tried, May 27, on *Solidago canadensis*, giving spermogonia June 2 and aecidia June 9. On the same date it was sown on *S. serotina*, giving spermogonia June 2 and aecidia June 11.

As the specific name *Solidaginis* is already employed in the genus Puccinia, I propose for this species the name of **Puccinia Caricis-Solidaginis.** A comparison of this species with *P. Caricis-Asteris* and *P. Caricis-Erigerontis* shows many resemblances, and it seems not improbable that the three represent more correctly the biological variations of one species. However, in the many cultures so far made no set of teleutospores has been found that would infect more than one of the three host genera, Aster, Erigeron, and Solidago.

SUMMARY.

The following is a complete list of successful cultures made during the season of 1902. It is divided into the two series: species previously reported by the writer or other investigators, and species now reported for the first time.

A. SPECIES PREVIOUSLY REPORTED.

1. UROMYCES EUPHORBIAE C. & P.—Aecidiospores from *Euphorbia humistrata* Engelm, sown on same host. Aecidiospores from *E. nutans* Lag. sown on same host. Uredospores from *E. dentata* Michx. sown on same host.

2. UREDO RUBIGO-VERA DC.—Uredospores from *Triticum vulgare* Vill. sown on same host.

3. PUCCINIA PECKII (De T.) Kellerm.—Teleutospores from *Carex trichocarpa* Muhl. and *C. stipata* Muhl. sown on *Onagra biennis* (L.) Scop.

4. PUCCINIA SAMBUCI (Schw.) Arth.—Teleutospores from *Carex trichocarpa* Muhl. and *C. lurida* Wahl. sown on *Sambucus canadensis* L., and aecidiospores from *S. canadensis* L. sown on *C. trichocarpa* Muhl.

5. PUCCINIA CARICIS-ASTERIS Arth.—Teleutospores from *Carex foenea* Willd. sown on *Aster paniculatus* Lam.

6. PUCCINIA CARICIS-ERIGERONTIS Arth.—Teleutospores from *Carex festucacea* Willd. sown on *Erigeron annuus* (L.) Pers., *E. philadelphicus* L., and *Leptilon canadense* (L.) Britt.

7. PUCCINIA CARICIS (Schum.) Reb.—Teleutospores from *Carex stricta* Lam. and *C. riparia* Curt. sown on *Urtica gracilis* Ait.

8. PUCCINIA VERBENICOLA (K. & S.) Arth.—Teleutospores from *Sporobolus longifolius* (Torr.) Wood sown on *Verbena stricta* Vent. and *V. urticifolia* L.

9. PUCCINIA WINDSORIAE Schw.—Teleutospores from *Tricuspis seslerioides* (Michx.) Torr. sown on *Ptelea trifoliata* L.

10. PUCCINIA HELIANTHI Schw.—Teleutospores from *Helianthus grosse-serratus* Mart. sown on same host, and on *H. Maximiliani* Schrad.

11. PHRAGMIDIUM SPECIOSUM Fr.—Teleutospores from cultivated rose sown on *Rosa humilis* Marsh.

B. SPECIES REPORTED NOW FOR THE FIRST TIME.

1. UROMYCES ARISTIDAE E. & E.—Teleutospores from *Aristida oligantha* Michx. sown on *Plantago Rugelii* Dec.

2. PUCCINIA JAMESIANA (Pk.) Arth.—Teleutospores from *Atheropogon curtipendulus* (Michx.) Fourn. sown on *Asclepias incarnata* L. and *A. syriaca* L.

3. PUCCINIA IMPATIENTIS (Schw.) Arth.—Teleutospores from *Elymus virginicus* L. sown on *Impatiens aurea* Muhl.

4. PUCCINIA SUBNITENS Diet.—Teleutospores from *Distichlis spicata* (L.) Greene sown on *Chenopodium album* L.

5. PUCCINIA AMPHIGENA Diet.—Teleutospores from *Calamovilfa longifolia* (Hook.) Hack. sown on *Smilax herbacea* L. and *S. hispida* Muhl.

6. PUCCINIA SIMILLIMA Arth.—Teleutospores from *Phragmites Phragmites* (L.) Karst. sown on *Anemone canadensis* L.

7. PUCCINIA CARICIS-SOLIDAGINIS Arth.—Teleutospores from *Carex Jamesii* Schw. and *C. stipata* Muhl. sown on *Solidago canadensis* L. and *S. serotina* Ait., and also from the former Carex host sown on *S. caesia* L., *S. ulmifolia* Muhl. and *S. rigida* L.

It will not be out of place to emphasize again the desirability of making field observations upon the association of aecidial, uredo, and teleutosporic forms within small areas. There is little chance for progress in establishing the connection of spore-forms through cultural work, except by acting upon the hints derived from field notes. Any acute observer is likely to be able to make one or more important deductions of this kind during a season, which may lead to valuable discoveries upon testing by cultures. If collectors would bear the matter in mind, the perplexing tangle of our knowledge of the heteroecious rusts would soon largely yield to experimental study.

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PURDUE UNIVERSITY,
Lafayette, Ind.